Conservation Service (NRCS) Soil Survey Geographic (SSURGO) data into a GIS Database:

Extracting and weighting SSURGO's hierarchical scheme for analytical applications

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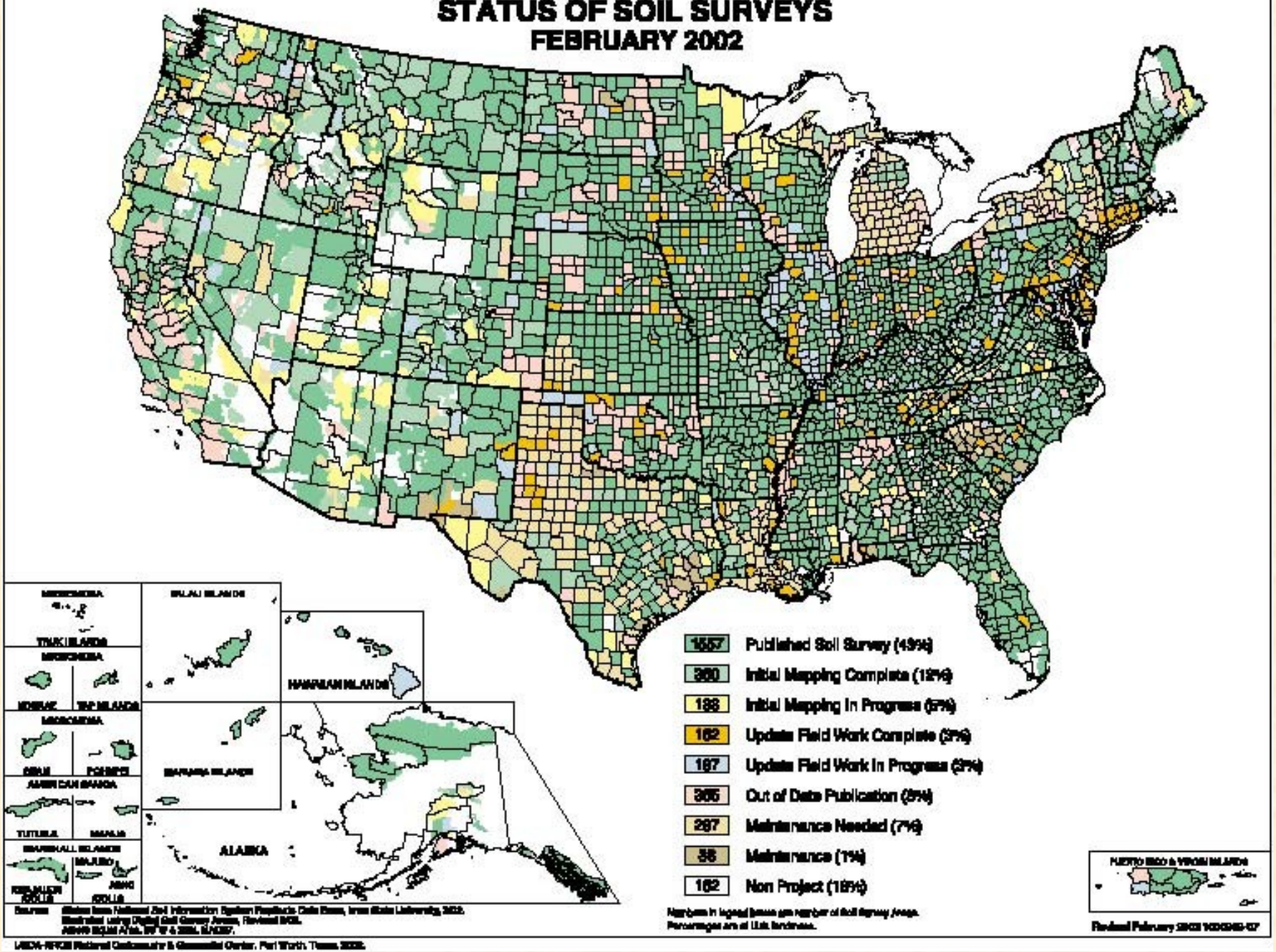
Objectives: SSURGO Overview

- SSURGO Data Availability Map
- SSURGO Content: How Can SSURGO Help You?
- NRCS Methodology for Deriving SSURGO
- SSURGO Data Accuracy

U.S. DEPARTMENT OF AGRICULTURE

NATURAL RESOURCES CONSERVATION SERVICE

STATUS OF SOIL SURVEYS
FEBRUARY 2002



Numbers in legend boxes are number of soil survey areas.
Percentages are of U.S. landmass.

Revised February 2002

How Can SSURGO Help You? A few applications suggested by NRCS

- Erodible area delineation
- Developing erosion control practices
- Landuse potential / landuse assessments
- Identifying potential wetlands and aquifer areas
- Rangeland potential
- Wildlife habitat suitability
- Woodland suitability
- Impact assessment potential

NRCS Methodology for Deriving SSURGO?

- Soil units delineated from field traverses and transects
- Aerial photo interpretation used for map base
- SSURGO data is a combination of spatial delineation from National Conservation soil Service maps published at the county level and aspatial data created from soil characteristics and tied to areas of corresponding soil types.
- NRCS started soil data compilation in 1899.

SSURGO Data Accuracy

- Scale ranges from 1:12,000 to 1:63,360
- SSURGO is used for agricultural conservation planning, range and timber management, county planning, and watershed management for parcel level analysis.
- SSURGO is not designed for site-specific land use suitability determinations, such as approval, siting, and sizing of septic tank absorption fields.
- State Soil Geographic Database (STATSGO) is at 1:250,000. County, state, regional, and national resource planning.
- National Soil Geographic Database (NATSGO) 1: 750,000. Regional and national resource planning.

SSURGO Data Accuracy Continued

- Map Unit Interpretation records (MUIR) collection of soil properties, interpretations, and performance data. It is utilized in conjunction with soil survey maps. SSURGO will replace MUIR eventually, but MUIR can be used if SSURGO is not available. (MUIR last updated in 1997). Data collected from field observations, transects and laboratory analyses and contains 88 physical and chemical, interpretations and performance data.

Objectives: Understanding SSURGO Spatial and Aspatial Features

- SSURGO File Naming Convention
- SSURGO Table Overview
- Synopsis for Table Relationships
- Table Relationship Terminology
- Primary/Foreign/Composite Keys
- Important Definitions to Know
- Map Feature Characteristics

SSURGO File Naming Convention

- _a - soil polygon
- _p - special soil point features
- _l - special soil line features
- _b - survey boundary polygons
- _q - quadrangle grid polygons

Note:

- All data resides as coverages and info tables.
- If SSURGO data not available, NRCS soil county hard copy maps and Mapunit Interpretations Record (MUIR) can be substituted.

SSURGO Tables

Soil survey area Map Unit Interpretations Record data consist of the following relational tables:

- **codes (data base codes)** stores information on all codes used in the data base
- **comp (map unit component)** stores soil component information " compyld (component crop yield) stores crop yield information for soil components
- **forest (forest understory)** stores information for plant cover as forest understory for soil components
- **helclass (highly erodible lands class)** stores the highly erodible land classification for wind and water assigned to the soil map units " hydcomp (hydric component information) stores data related to the hydric classification, criteria, and landform

SSURGO Tables Continued

- **inclusn (map unit inclusion)** stores the name of soils included in the soil map units
- **interp (interpretation)** stores soil interpretation ratings (both limitation ratings and suitability ratings) for soil components
- **layer (soil layer)** stores characteristics of soil layers for soil components
- **mapunit (map unit)** stores information that applies to all components of a soil map unit
- **mucoacre (map unit county acres)** stores the number of acres for the map unit within a county

SSURGO Tables Continued

- **plantcom (plant composition)** stores plant symbols and percent of plant composition associated with soil components
- **plantnm (plant name)** stores the common and scientific names for plants listed in the data base
- **rangenm (range name)** stores the range site names
- **rsprod (range site production)** stores range site productivity information for soil components
- **ssacoac (soil survey area county acreage)** stores the acreage for the county within the boundary of the soil survey area
- **ssarea (soil survey area)** stores information that will apply to an entire soil survey

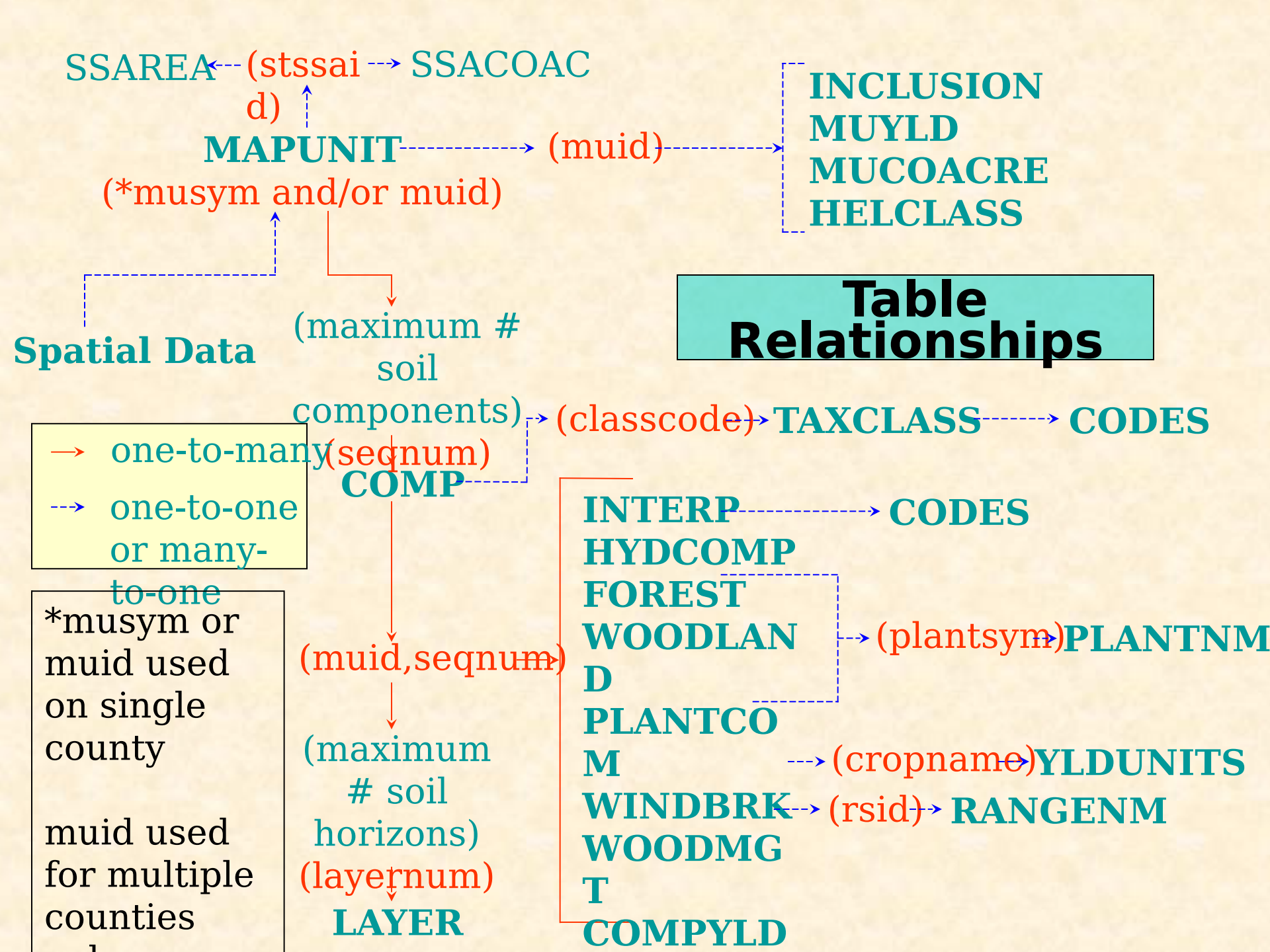

SSAREA
(stssaid)
SSACOAC
MAPUNIT
(*musym and/or muid)
(muid)
INCLUSION
MUYLD
MUCOACRE
HELCLASS
Table Relationships
Spatial Data
(maximum # soil components)
(seqnum)
COMP
(classcode)
TAXCLASS
CODES
→ one-to-many
--> one-to-one or many-to-one
*musym or muid used on single county
muid used for multiple counties
(muid,seqnum)
(maximum # soil horizons)
(layernum)
LAYER
INTERP
CODES
HYDCOMP
FOREST
WOODLAND
PLANTCOM
WINDBRK
WOODMGT
COMPYLD
(plantsym)
PLANTNM
(cropname)
YLDUNITS
(rsid)
RANGENM

Table Relationships Terminology

- **One-to-one:** one unique value in source table to one unique value in the destination table
- **many-to-one:** many values in source table to one equivalent value in the destination table per record
- **one-to-many**: one value in source table to many values in destination table per record
- **many-to-many:** many values in source table to many values in destination table. Not supported with ESRI products.
- **Cardinality** refers to the number of matching records in the origin and destination tables.

Table Relationships Terminology Continued

- The **map attribute table**, a.k.a. origin table, is what tables are joined to.
- Tables joined to the origin table are called **destination tables**, a.k.a. target table, where the join goes from the destination tables to the origin table.

Primary / Foreign / Composite Keys

- **Seqnum-** sequence number identifying the sequence of components in a mapunit. (1 - 3 potential components per mapunit)
- **muid-** map identification symbol. A concatenation of soil survey area (ssaid) and mapunit symbol (musym). A unique identifer for a mapunit within a state. E.g. ssaid 061; musym 1 --> muid = 061001
- **musym-** mapunit symbol used to identify the soil mapunit on the soil map
- **stssaid-** state soil survey area id. Concatenation of FIPs alpha code for a state and the soil survey area symbol (ssaid)
- **clascode-** taxonomic classification code for soil

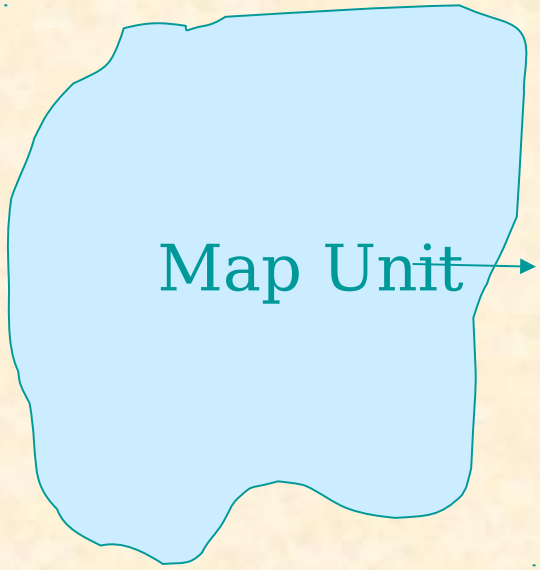
Primary / Foreign / Composite Keys Continued

- **plantsym-** symbol uised to identify a specific plant
- **cropname-** common name for the crop which a yield is given
- **rsid-** range site identification code used to identify the NRCS range site

Important Definitions to Know

- muid = concatenation of FIPS code and mapunit symbol
- Largest percentage component always has a seqnum of 1. ‘seqnum’ designates component level, while comppct, designates percentage of area occupied by each component.
- Layernum is a number assigned to a layer. A soil type can have up to 6 delineated horizons but there are usually 3 or less assigned in SSURGO.
- While examining soil horizons and collapsing the three dimensional attributes a composite key is required. To create this key the user will concatenate MUID and SEQNUM.

Map Feature Characteristics



Map Unit → Components
1
2
3

Components → Component's Properties
1
2
.
60

Layer(s)
1
2
.
6

Layer properties
1
2
.
28

- A single map unit can have one to three soil components or types
- Soil components designated as percent cover and not by polygon delineation
- Each component has 60 properties tied to 84 fields

- 1 - 6 soil layers exist for each component
- 28 properties are possible for each layer

Objectives: Examples of Extracting Soil Characteristics from the Database

- Extracting Soil Characteristics from the Database
  Examples:
    Water Table Depth
    Available Water Capacity

Extracting Soil Characteristics from the Database

- Because the bulk of SSURGO data resides as aspatial data, one major hurdle for GIS analysts is to collapse the on-to-many relationships to a one-to-one relationship before analysis can occur.
- The provided document will illustrate the simple calculations for such a task.

Example Water Table Depth: Table Calculations

$$WA_WTDEP = \frac{\sum_{1}^{i} ((wtdep_{i-1} + wtdep_{i}) / 2) * comppct}{i}$$

* comppct has been abbreviated here to equal (comppct /

Water Table Depth

Wtdeph: maximum value for the range in depth to the seasonally high water table during the months specified.

Wtdepl: minimum value for the range in depth to the seasonally low water table during the months specified.

Component (s) 70% Wtdeph(1) 1 Wtdepl(1) 0

(1)
(2) 20% 0
(3) 10%

Wtdeph(3) Wtdepl(3) 3 4.5

Wtdeph(2) 6 Wtdepl(2) 3.5

Calculating the Weighted Average for Water Table Depth

$$WA_WTDEP = \frac{\sum_{1}^{i} ((wtdep_{i-1} + wtdep_i)/2) * comppct}{i}$$

$$WA_WTDEP(1) = (0 + 0) / 2 * .70 = 0$$

$$WA_WTDEP(2) = (6 + 3.5) / 2 * .2 = .95$$

$$WA_WTDEP(3) = (4.5 + 3) / 2 * .1 = .375$$

$$WA_WTDEP = (0 + .95 + .375) / 3 = .4$$

The average distance to the seasonally high water table depth for the mapunit is .4 feet

Example Available Water Capacity: Table Calculations

Average inches of available water summed for all soil horizons:

$$WAS_AWC = \frac{\sum_{1}^{i} [(layernum_{bh} - hlayernum_{ti}) * ((awc_{tl} + awch_{bh})/2) * comppct_{ti}]}{i}$$

* comppct has been abbreviated here to equal (comppct /

Soil Horizon Layer Depth per Compon

This information is found in the layer SSURGO table

layerdeph: Distance in inches to the bottom of the deepest layer

layerdepl: Distance in inches to the bottom of the shallowest layer

Component (1) 70%
(2) 20%
(3) 10%

Layerdeph (1) 2
(2) 13
(3) 60
(4)
(5)
(6)

Layerdepl (1) 0
(2) 2
(3) 10
(4)
(5)
(6)

Layerdeph (1) 2
(2) 10
(3) 60
(4)
(5)
(6)

Layerdepl (1) 0
(2) 2
(3) 20
(4)
(5)
(6)

Layerdeph (1) 2
(2) 20
(3) 60
(4)
(5)
(6)

Layerdepl (1) 0
(2) 2
(3) 2
(4)
(5)
(6)

Available Water Capacity

awch: Maximum value for the range of available water capacity for the soil layer or horizon, expressed as inches/inch.

awcl: Minimum value for the range in moist bulk density of the soil layer or horizon, expressed as grams per cubic centimeter.

Component (1) 70%
(2) 20%
(3) 10%

awch (1) .19
(2) .18
(3) .18
(4)
(5)
(6)

awcl (1) .17
(2) .16
(3) .14
(4)
(5)
(6)

awch (1) .15
(2) .15
(3) .19
(4)
(5)
(6)

awcl (1) .13
(2) .11
(3) .12
(4)
(5)
(6)

awch (1) .08
(2) .08
(3) .1
(4)
(5)
(6)

awcl (1) .04
(2) .04
(3) .08
(4)
(5)
(6)

Calculating the Weighted Average for Available Water Capacity Component 1

Average inches of available water summed for all soil horizons:

$$WAS_AWC = \frac{\sum_{1}^{i} [(layernum_{bot_i} - layernum_{top_i}) * ((awc_{l_i} + awc_{h_i}) / 2) * comppct_i]}{i}$$

WAS_AWC = (2 - 0) * [(.19 + .17) / 2] * .7 = .252

WAS_AWC = (13 - 2) * [(.18 + .16) / 2] * .7 = 1.3

WAS_AWC = (60 - 13) * [(.18 + .14) / 2] * .7 = 5

Sum of three layers = 6.825

Average Available Water Capacity for this component is 6.825.

* comppct has been abbreviated here to equal (comppct /

Calculating the Weighted Average for Available Water Capacity Component 2

Average inches of available water summed for all soil horizons:

$$\text{WAS_AWC} = \frac{\sum_{1}^{i} [(layernum_{bot_i} - layernum_{top_i}) * ((awc_l + awch_i)/2) * comppct_i]}{i}$$

WAS_AWC = (2 - 0) * [(.08 + .04) / 2] * .2 = .024

WAS_AWC = (13 - 2) * [(.08 + .04) / 2] * .2 = .2

WAS_AWC = (60 - 13) * [(.1 + .08) / 2] * .7 = .7

Sum of three layers
= .960

Average Available Water Capacity for this component is .960.

* comppct has been abbreviated here to equal (comppct

Calculating the Weighted Average for Available Water Capacity Component 3

Average inches of available water summed for all soil horizons:

$$WAS_AWC = \frac{\sum_{1}^{i} [(layernum_{hi} - layernum_{lo}) * ((awc_{l} + awc_{h}) / 2) * comppct_{i}]}{i}$$

WAS_AWC = (2 - 0) * [(.15 + .13) / 2] * .7 = .028

WAS_AWC = (13 - 2) * [(.15 + .11) / 2] * .7 = .10

WAS_AWC = (60 - 13) * [(.19 + .12) / 2] * .7 = .7

Sum of three layers = .907

Average Available Water Capacity for this component is .907.

* comppct has been abbreviated here to equal (comppct

Calculating the Weighted Average for Available Water Capacity Average of Three Components

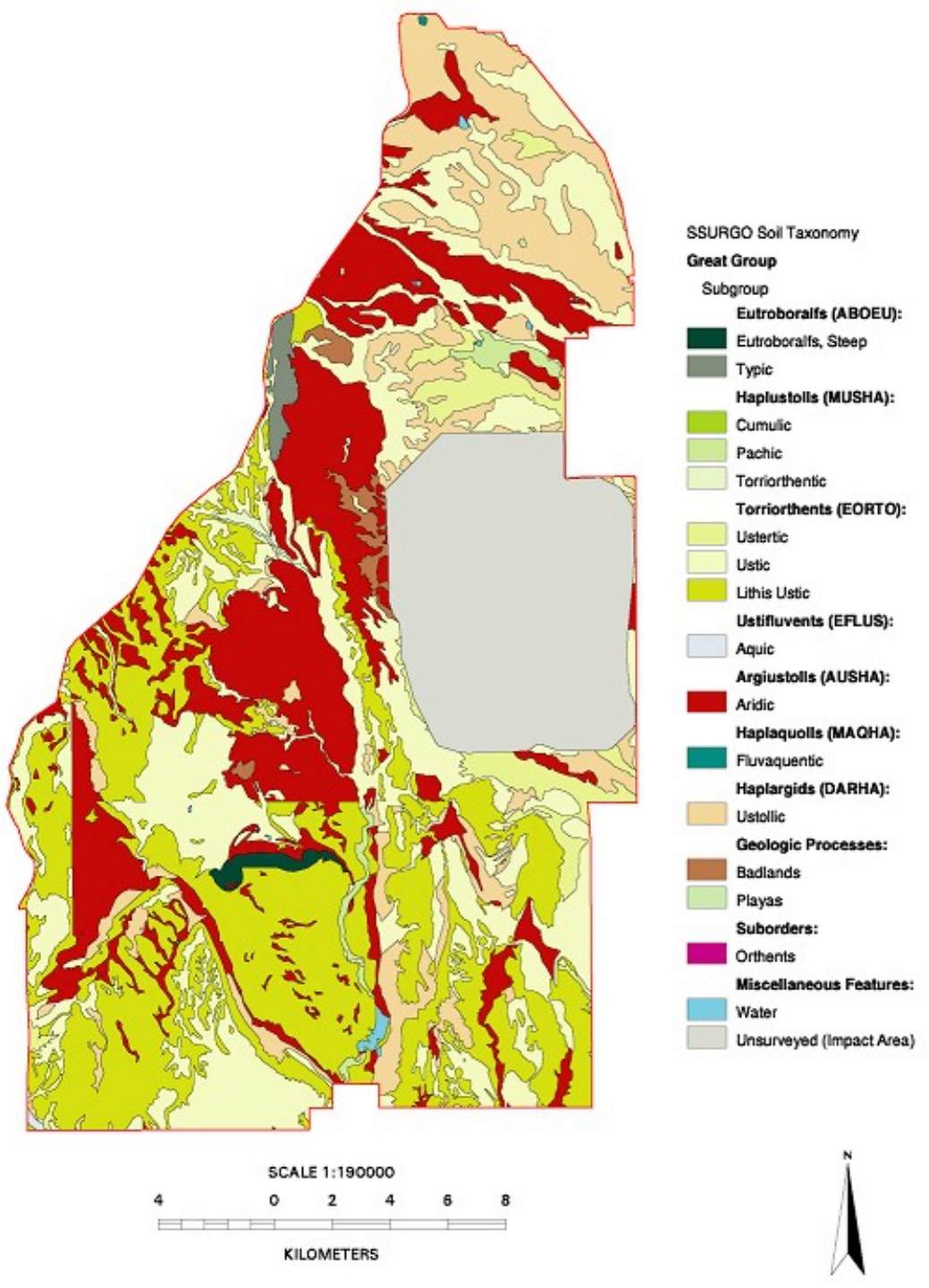
AWC = (6.825 + .960 + .907) / 3
= 2.897

2.897 cm^3 of water that should be available to plants if the soil, inclusive of rock fragments, were at field capacity for this mapunit.

Objectives: Product Example and GIS Protocols

- Fort Carson Soil Taxonomic Subgroups
- GIS Protocols (handout)
- Common Issues to Address with SSURGO Accuracy
- Summary
- Helpful URLs

Fort Carson Colorado Site Example: Soil Subgroups



GIS Protocols

- Access Table Protocols
- ArcGIS Data Protocols
- ArcView Data Protocols
- ArcInfo Data Protocols (Not Elaborated on due to lack of users)

Common Issues to Address with SSURGO Properties/Accuracy

- Soil properties do not usually match along county boundaries. Not an easy work around.
- Suggested that data be compiled by county level first. Join your extracted soil properties to the spatial data at county level. Then examine conflicts along county boundaries and decide how to tackle the issues.
- Resolving boundary issues is difficult and requires soil scientist’s expertise.

Summary

- Whoa! This was a quick overview and introduction to SSURGO
- A majority of the information is provided here and on the handout to assist GIS users with incorporating SSURGO data analysis for your Installation’s needs
- Don’t be intimidated by the calculations. Break your work down and look at each component. As you dive in the information here will began to sink in

Helpful URLs

- Penn. State Univ online definitions of NRCS definitions

http://www.essc.psu.edu/soil_info/

- National Soil Survey Handbook

http://www.statlab.iastate.edu/soils/nssh/

- Soil Survey Manual

http://www.statlab.iastate.edu/soils/ssm/gen_cont.html

- A Compendium of On-Line Soil Survey Information

http://www.itc.nl/~rossiter/research/rsrch_ss_digital.html

- NRCS

http://www.nrcs.usda.gov/

- Soil Survey and Maps-Status

http://www.statlab.iastate.edu/soils/soildiv/sslists/sslisthome.html

URLs Continued

- Soil Information and Data http://www.statlab.iastate.edu/soils/index.html
  - Map Unit Interpretation Database (MUIR)
  - Official Soil Series Descriptions (collection of detailed soil series descriptions
  - Soils Series Classification Database
  - National Soil Characterization Database